Royal Reinecke
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LIGO

Progress Report for August 1, 2005

Work completed in the past month

This month I experienced a significant setback as the materials I needed for my original project did not arrive. However, I also found myself with the opportunity to be in the position of lead researcher, coming up with something new to study. During the course of my previous work I noted an interesting thermal self-locking phenomena, so I decided to study this. Thus my progress slowed for a while, but has now picked up again as I have once again found an area of focus.

Process of work so far

Currently I have been studying the amplitude of oscillations in reflected power as a function of sweep frequency. I have also measured the error signal as a function of sweep frequency for different laser powers. In addition I noted the minimum and maximum reflected power, and the power at which thermal locking occurs for various laser powers. Thus I could find the minimum power needed for my particular cavity to induce self-locking.

In general, my observations can be explained by theoretical models. Measurements of reflected power signal amplitude at different sweep frequencies indicate thermal locking is indeed occurring, just as a camera on the TEM_{00} mode shows it to hold steadily locked.
Also, thermal self-locking is more readily apparent at higher powers, and the laser locks for a much longer length of time at these powers. As predicted, thermal self-locking cannot occur below a certain power threshold. Amplitude of error signal decreases as sweep frequency decreases which makes sense because it is easier for the system to keep up with lower frequencies.

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Problems encountered

At first I was varying the power of the laser by changing a current. However, this leads to strange behavior of the laser. So I installed two half wave plates. Then I could change the power by changing the angle of one of the half wave plates. I used a bolometer to create a calibration curve such that I could know what power corresponded to a given angle of the first half-wave plate. Also I was using a sweep amplitude that was wider than resonance, so I narrowed that down.

Changing research goals

Originally I planned to measure the thermal coefficients for mirrors with new silica-tantala coatings containing a secret special dopant. Unfortunately the mirror I needed did not arrive. Instead, a mirror arrived with the silica-tantala coating on a fused silica substrate rather than a sapphire substrate. Thus coating thermal noise cannot be measured because it is too similar in both the coating and the substrate.

During the course of my research, I noted a thermal self-locking phenomena, and so I decided to study this instead. Now I am focusing on more fully understanding thermal self-locking by fitting experimental data to theory. I also hope to more fully developing my mathematical model in order to better understand the stability of this locking.

Interaction with mentor

I see my mentor every day. When I am unclear on a concept, he will always explain and work through it with me. Each Tuesday we have a group lunch. Then on Thursdays, we all meet to discuss our progress, and some members of the group give presentations.